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STANDARD TEST METHOD FOR EVALUATING TRIBOELECTRIC CHARGE GENERATION AND DECAY

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TEST REPORT

Standard Test Method For Evaluating Triboelectric Charge Generation and Decay

ISSUED BY

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1.0 SCOPE

This method describes the triboelectric device used at Kennedy Space Center (KSC) to test the electrostatic properties of materials, the procedure used for testing, the preparation and conditioning of the samples, and the data gathering system. This method is especially applicable for testing thin plastic films, tapes, cloth fabrics, solid surfaces up to approximately 0.5-in thick, and surface coatings such as paint or anti-static coatings applied to thin solid samples.

2.0 SIGNIFICANCE AND USE

2.1 Increasing attention is being given to the problem of static electricity because of its ability to damage or destroy certain semiconductor devices, unexpectedly initiate ordnance devices, ignite explosive atmospheres, and surprise workers doing critical jobs, thus causing undesirable consequences and injuries to occur. These hazards associated with electrostatic discharge (ESD) are a continuing safety and financial concern to the scientific community. Thin materials like plastic films and packaging materials are some of the materials most likely to develop damaging static charge build-up.

2.2 This test method may be used to evaluate the static electrical charge generated and the rate of discharge from materials under controlled environmental conditions.

3.0 SUMMARY OF METHOD

Specimens cut from the material to be tested are preconditioned to the required test humidity for 24 hours prior to testing. The test specimen is then mounted in the specimen holder, a static charge is generated by rubbing with a felt polytetrafluoroethylene (PTFE) covered wheel for 10 seconds, and the charge generated and decay rate are monitored on a digital storage oscilloscope.

4.0 APPARATUS

4.1 The Triboelectric Device

The triboelectric test device is shown in Figures 1 thru 12, and consists of a grounded aluminum frame with two cutouts in the front face plate. The lower right cutout houses the static detector head. (This detector head is a type 2501 static detecting head made by Keithly Instruments, Inc. The output of this detector is electrically connected to a Keithly Model 610 solid state electrometer). The upper left cutout is for the rubbing wheel used to generate the triboelectric charge. This rubbing wheel is connected to a 1/8 HP electric drive motor with a solid state speed control unit (a G. K. Heller Model HST 20 is satisfactory). A manual control lever is used to slide the motor/rubbing wheel combination forward so that the rubbing wheel makes intimate contact with the test specimen at the proper time. The test pressure is held constant during the test by means of a weight and cord system. In this system a cord is attached to the motor system, run over a pully wheel, and the proper weight is attached to the end of the cord (at present a weight of 3 pounds is used). The test specimen is mounted on a grounded aluminum sample holder in a taut condition.

4.2 <u>Rubbing Wheels</u>

The rubbing wheels all have a diameter of 5 inches. The standard wheel used has a Micarta back, a one inch thick foam cushion, and a felt teflon rubbing surface. Other wheel types are also available for specialized testing. One of these wheels has a solid teflon surface with a convex surface radius of 12 inches while another has a soft wool surface. Wheels with other specialized surfaces can readily be made as the need dictates.

4.3 <u>Data Gathering System</u>

The oscilloscope used is a Nicolet Model 3091 digital oscilloscope with memory. The oscilloscope trigger is initiated by a 6 volt battery connected to the oscilloscope trigger circuit through a microswitch on the sliding mechanism of the rubbing wheel. When the rubbing wheel is moved away from the sample (thus ceasing charge generation), the microswitch initiates the scope trigger. The detector head senses the electrostatic field and the electrometer generates a DC voltage proportional to the electrostatic field sensed by the detector head. This voltage is fed into the oscilloscope input and is displayed on the oscilloscope Y axis versus time. The zero time is the time the microswitch circuit triggers the oscilloscope sweep which occurs at the cessation of sample rubbing. The oscillograph presentation can also be recorded on the x-y plotter which is directly connected to the oscilloscope. The plotter can make an 8 1/2 inch by 11 inch record of the data as shown in Figure 13. The oscillograph also has a digital interface to provide the data to a digital computer system for further analysis and for storage.

5.0 PREPARATION OF TEST SPECIMENS

5.1 Cut five specimens, each 7 5/8 inch square from the material to be tested.

5.2 Condition the test specimens at the desired relative humidity for a minimum of 24 hours before testing.

6.0 TEST PROCEDURE

The procedure for testing is as follows:

1. Cut test samples into 7 5/8 inch squares.
2. Condition test samples at the desired test humidity and temperature for a minimum of 24 hours.
3. Turn on electrometer and oscilloscope and allow 30 minute warm-up.
4. Mount test sample in sample holder.
5. Verify or install the proper weights on the cord. Three pounds is the standard test force used at KSC.
6. Turn on the static eliminator for 30 seconds to remove any residual static charge.
7. Turn on rubbing wheel motor and adjust to 200 rpm.
8. Adjust oscilloscope for desired display.
9. Zero electrometer.
10. Raise sample holder.

11. Move control lever to initiate rubbing of test sample and continue rubbing for precisely 10 seconds (during this rubbing time the scope circuit must be armed and the electrometer ungrounded).

12. Retract rubbing wheel which permits sample to drop in front of detector head and initiates measurement of data.

13. Record voltage versus time for the peak voltage and at 0.5, 1.0, 2.0, 3.0, 4.0, and 5.0 seconds.

14. Repeat test with fresh sample beginning with step 4.

7.0 ELECTROSTATIC ACCEPTANCE CRITERIA

Acceptance Criteria: The electrostatic voltage generated by the triboelectric device shall be 350 volts or less, 5 seconds after termination of charge generation. The test environment shall be 75°F ± 5°F and 45% relative humidity. For materials to be used below 45% relative humidity it is required that the material be tested at the lower humidity.

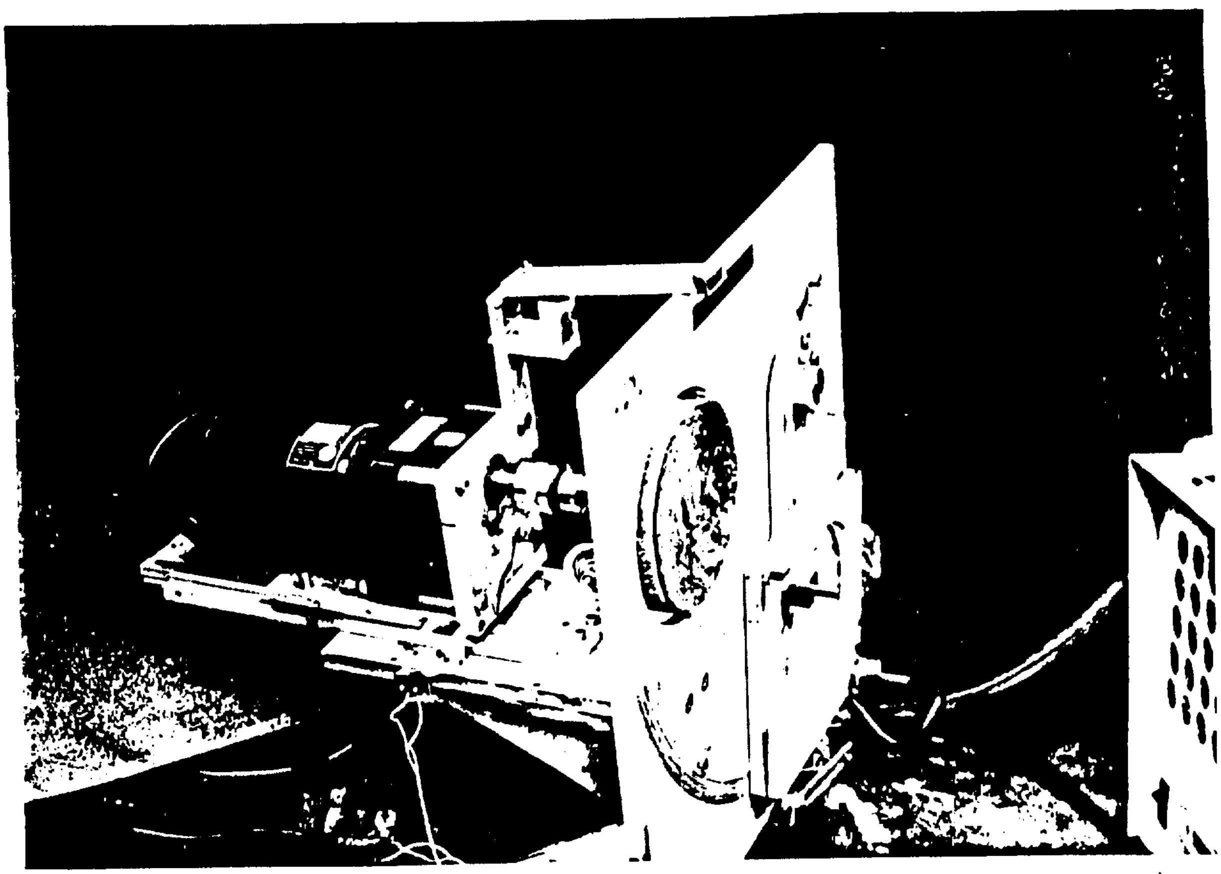
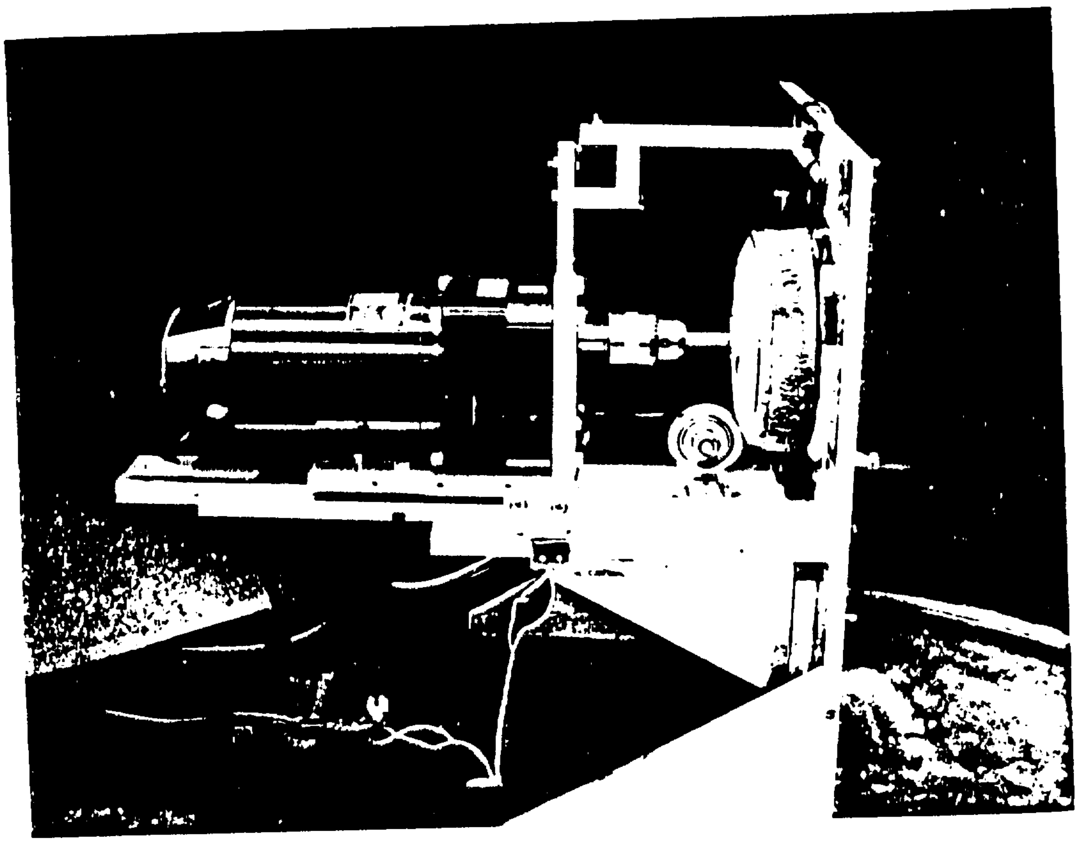
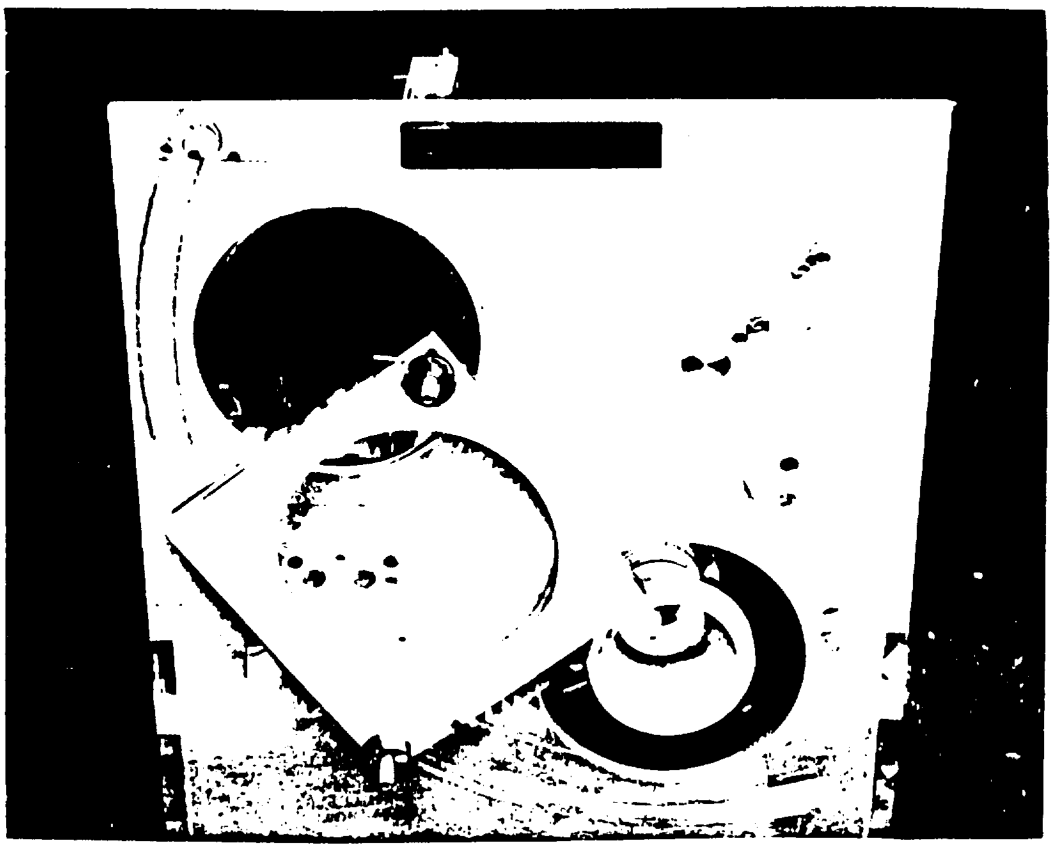


FIGURE 1
TRIBOELECTRIC TEST APPARATUS



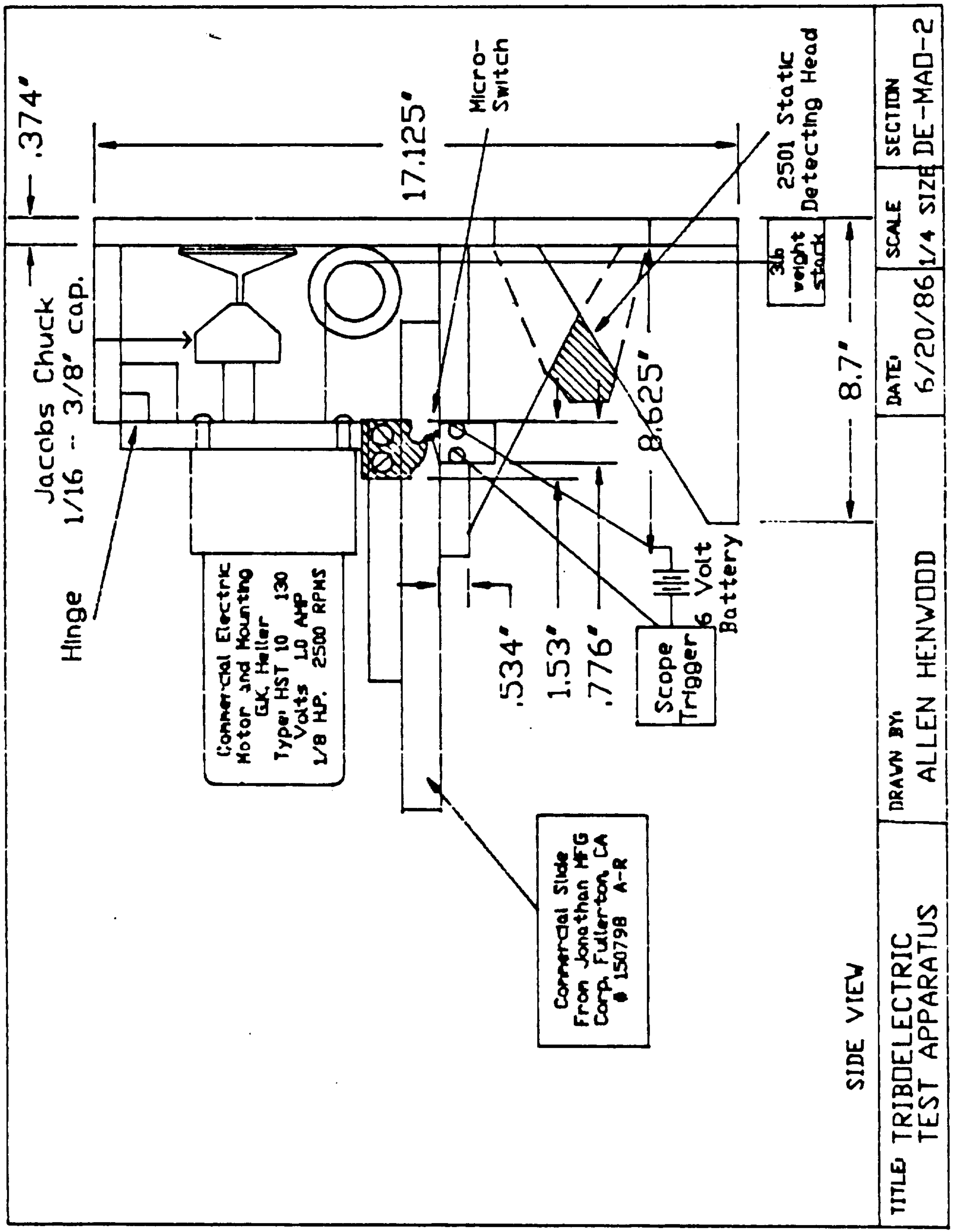
SIDEVIEW

FIGURE 2
TRIBUELECTRIC TEST APPARATUS



FRONTVIEW

FIGURE 3
TRIBOELECTRIC TEST APPARATUS



.374"
17.125"
Micro-Switch
2501 Static Detecting Head
Jacobs Chuck 1/16 - 3/8" cap.
3lb weight stack
8.7"
8.625"
Hinge
Commercial Electric Motor and Mounting G.K. Heller Type: HST 10 130 Volts 1.0 AMP 1/8 H.P. 2500 RPMS
.534"
1.53"
.776"
Scope Trigger
6 Volt Battery
Commercial Slide From Jonathan MFG Corp. Fullerton, CA # 150798 A-R
SIDE VIEW
TITLE: TRIBOELECTRIC TEST APPARATUS
DRAWN BY: ALLEN HENWOOD
DATE: 6/20/86
SCALE 1/4
SIZE
SECTION DE-MAD-2

FIGURE 4

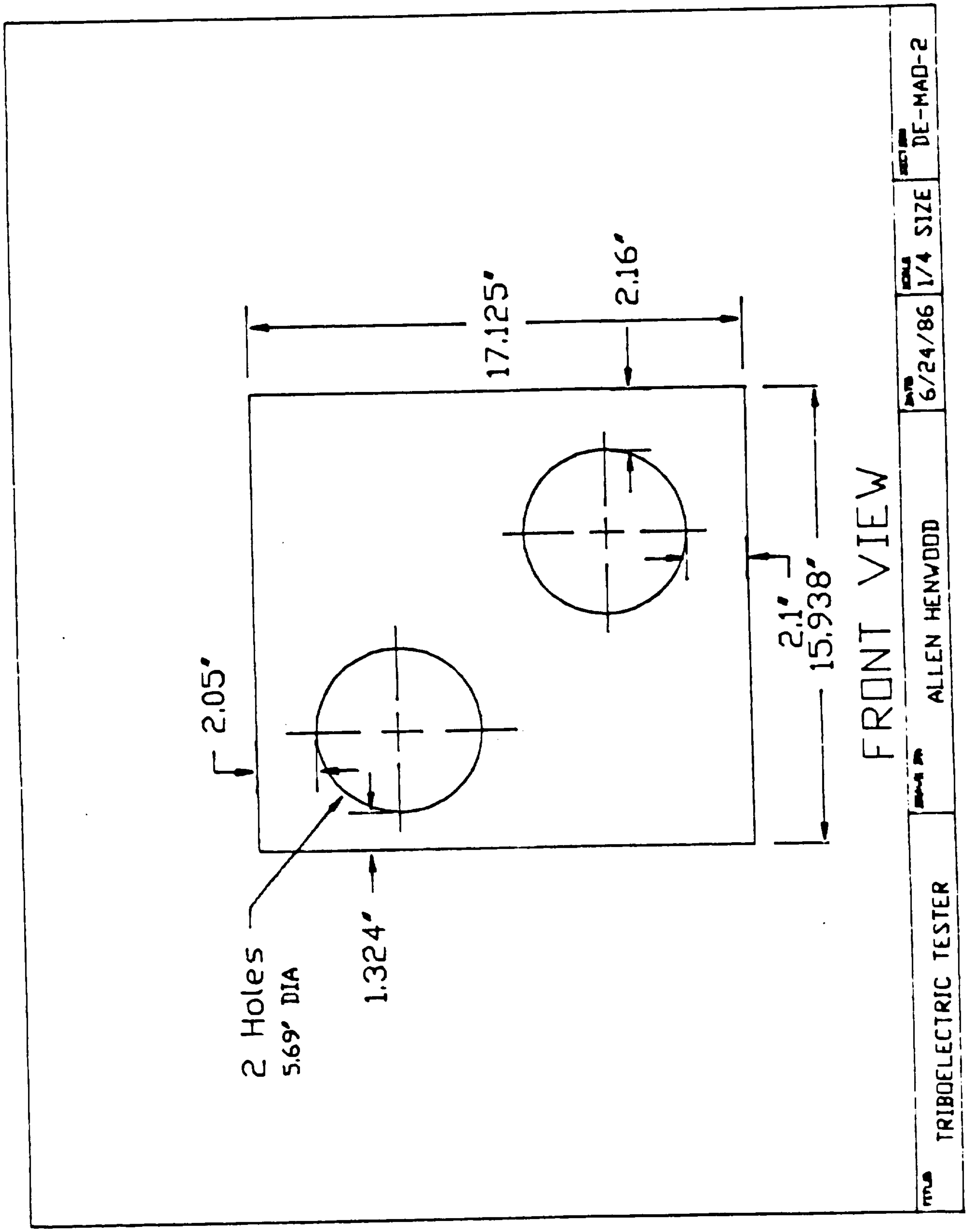

17.125"
2.16"
2.05"
2.1"
15.938"
1.324"
2 Holes
5.69" DIA
FRONT VIEW
DE-MAD-2
1/4 SIZE
6/24/86
ALLEN HENWOOD
TRIBOELECTRIC TESTER

FIGURE 5

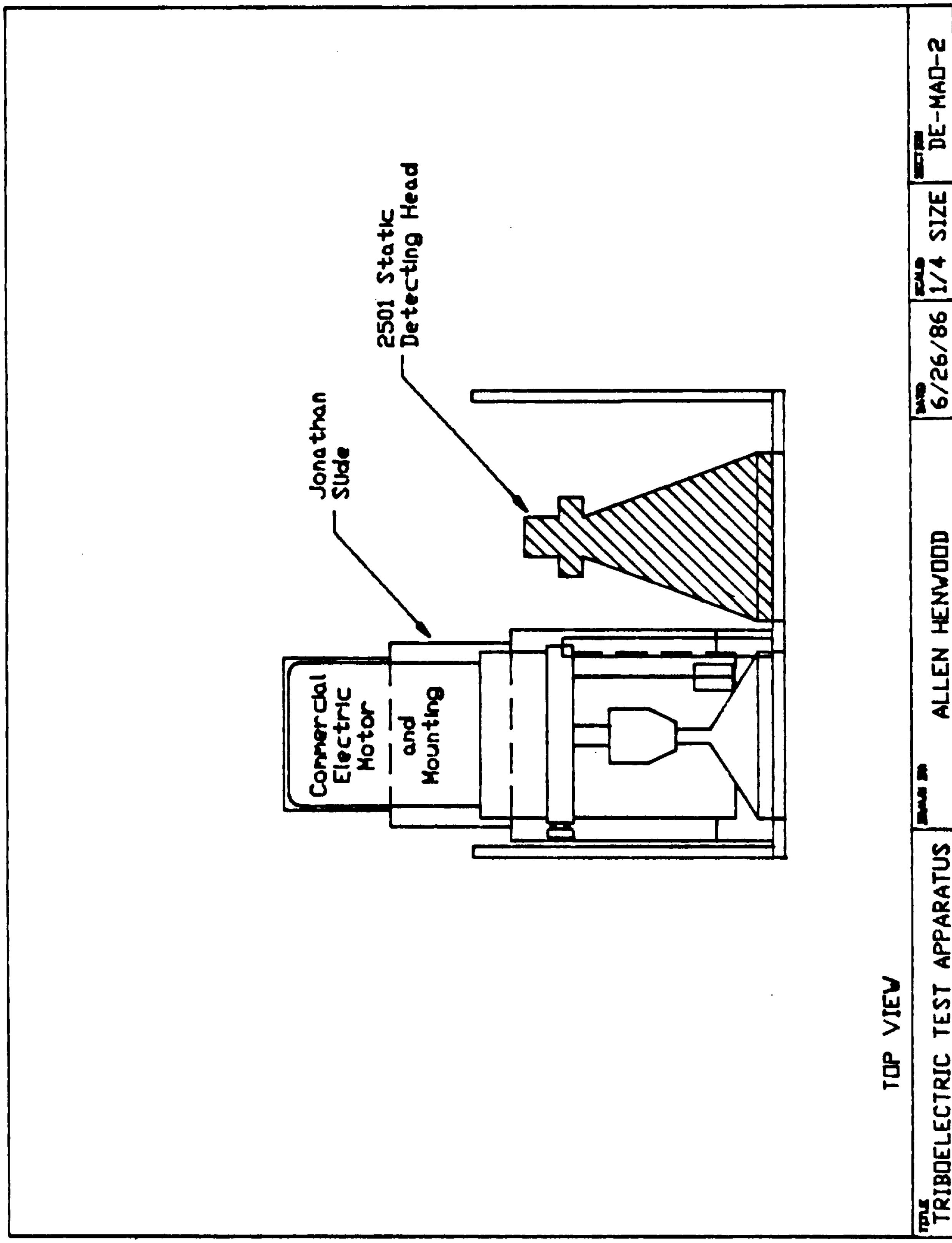

2501 Static
Detecting Head
Jonathan
Slide
Commercial
Electric
Motor
and
Mounting
TOP VIEW
TRIBOELECTRIC TEST APPARATUS
ALLEN HENWOOD
6/26/86
1/4 SIZE
DE-MAD-2

FIGURE 6

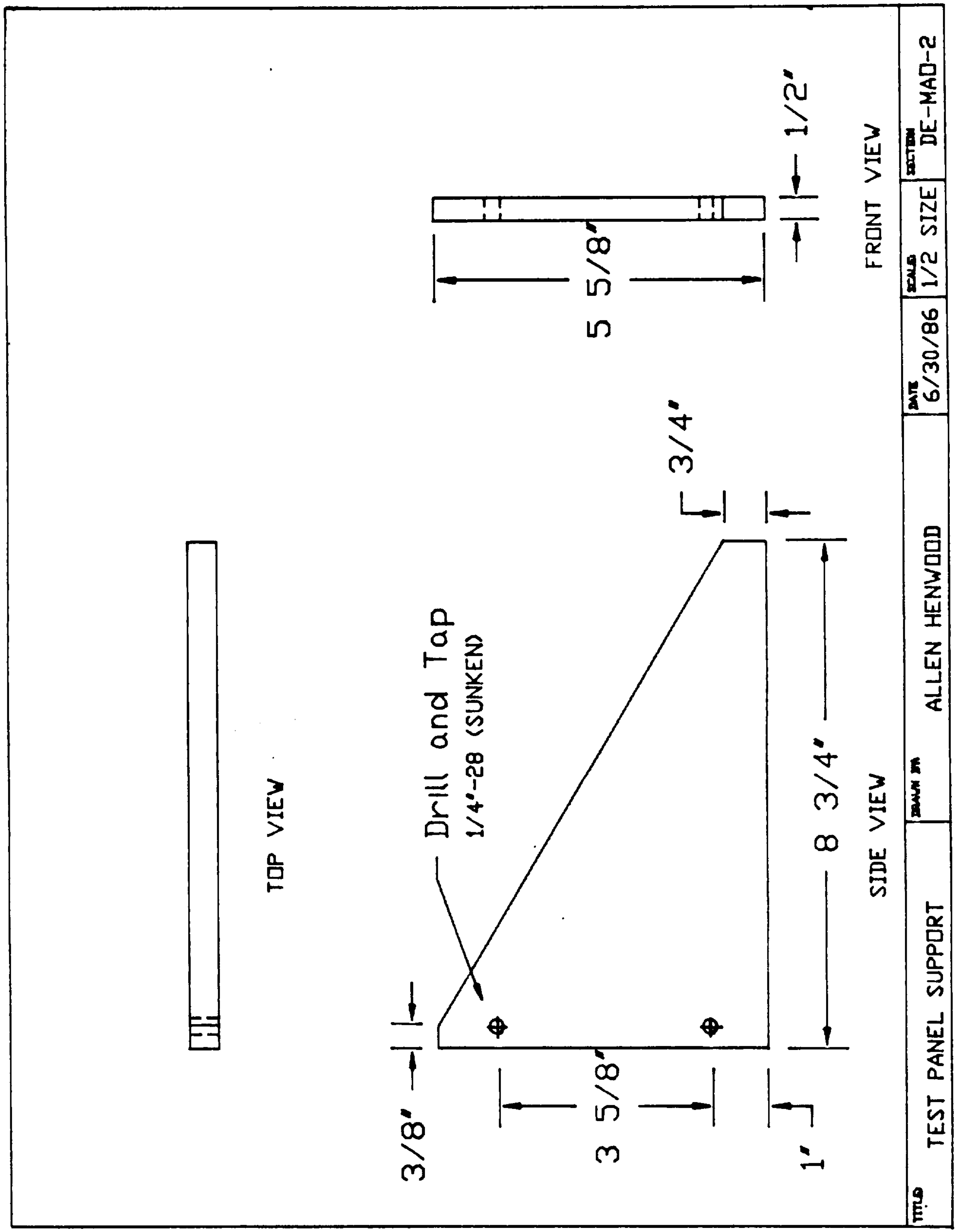

TOP VIEW
SIDE VIEW
FRONT VIEW
Drill and Tap
1/4"-28 (SUNKEN)
3/8"
3 5/8"
1"
8 3/4"
3/4"
5 5/8"
1/2"
TITLE TEST PANEL SUPPORT
DRAWN BY ALLEN HENWOOD
DATE 6/30/86
SCALE 1/2 SIZE
SECTION DE-MAD-2

FIGURE 7

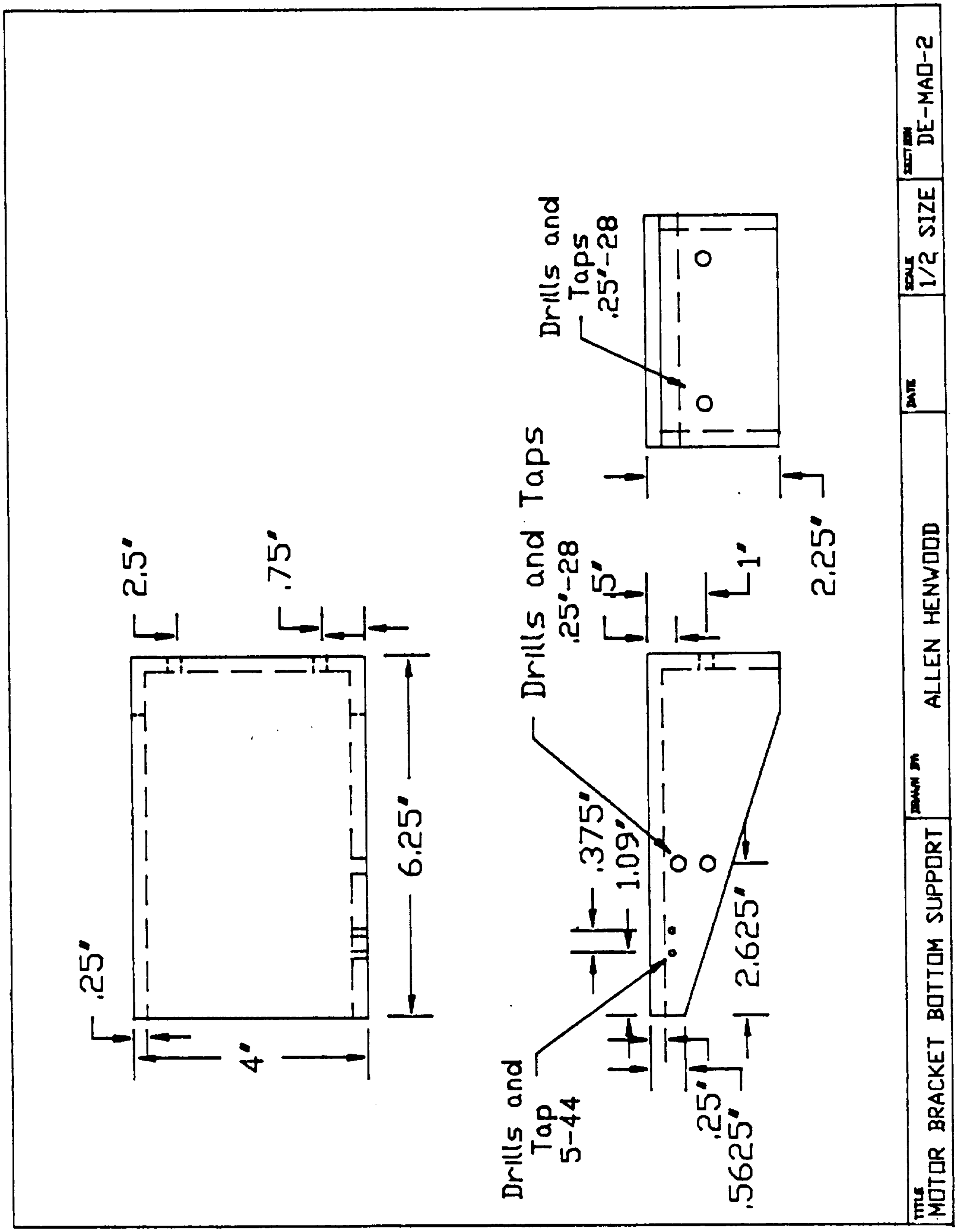

Drills and Taps .25"-28
Drills and Taps .25"-28
Drills and Tap 5-44
2.5"
.75"
.25"
4"
6.25"
.5"
1"
2.25"
.375"
1.09"
2.625"
.25"
.5625"
TITLE MOTOR BRACKET BOTTOM SUPPORT
DRAWN BY ALLEN HENWOOD
DATE
SCALE 1/2 SIZE
SECTION DE-MAD-2

FIGURE 8

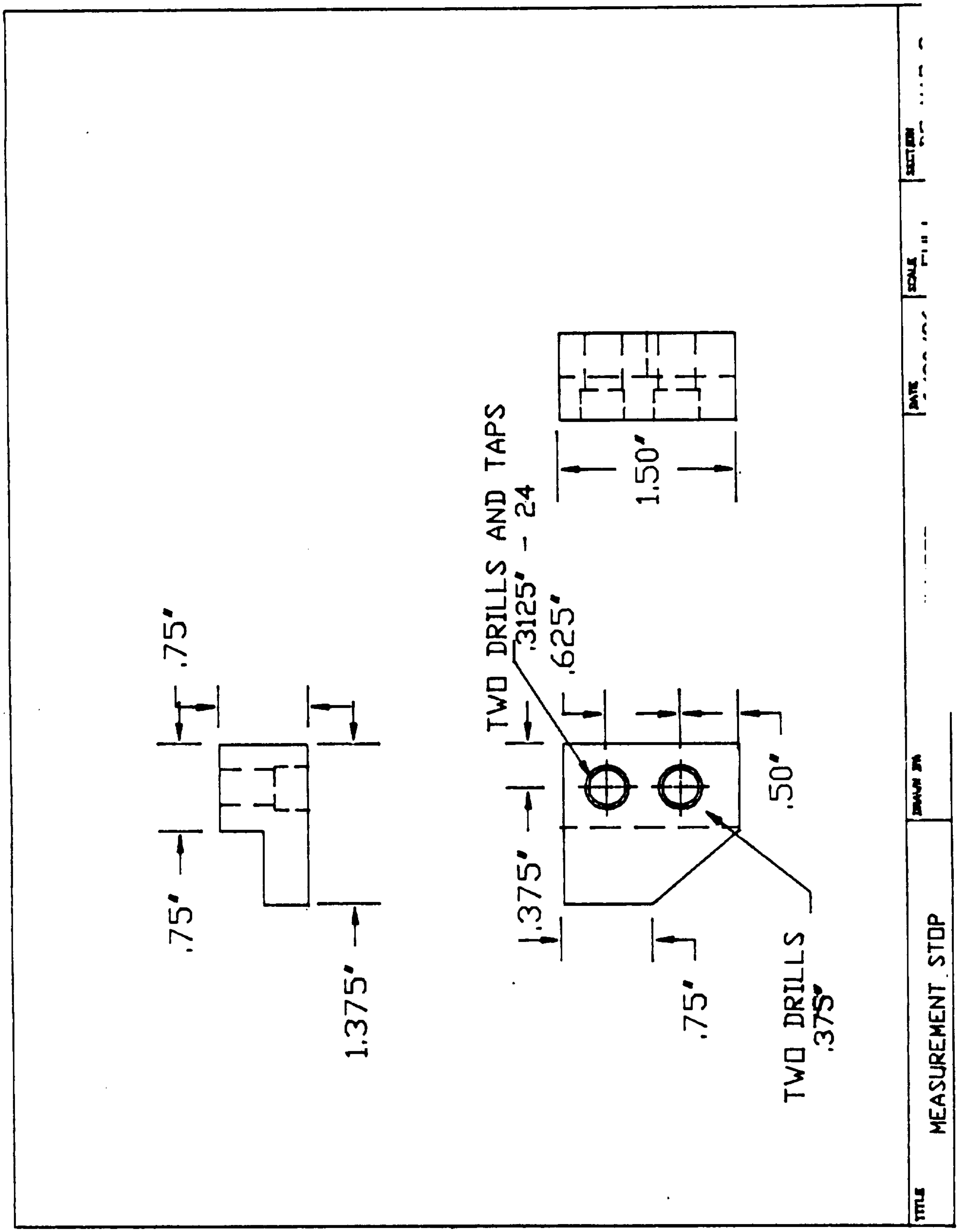

TWO DRILLS AND TAPS
.3125" - 24
.625"
.75"
.75"
1.375"
1.375"
.75"
1.50"
.50"
TWO DRILLS
.375"
TITLE
MEASUREMENT STOP
DRAWN BY
DATE
SCALE
SECTION

FIGURE 9

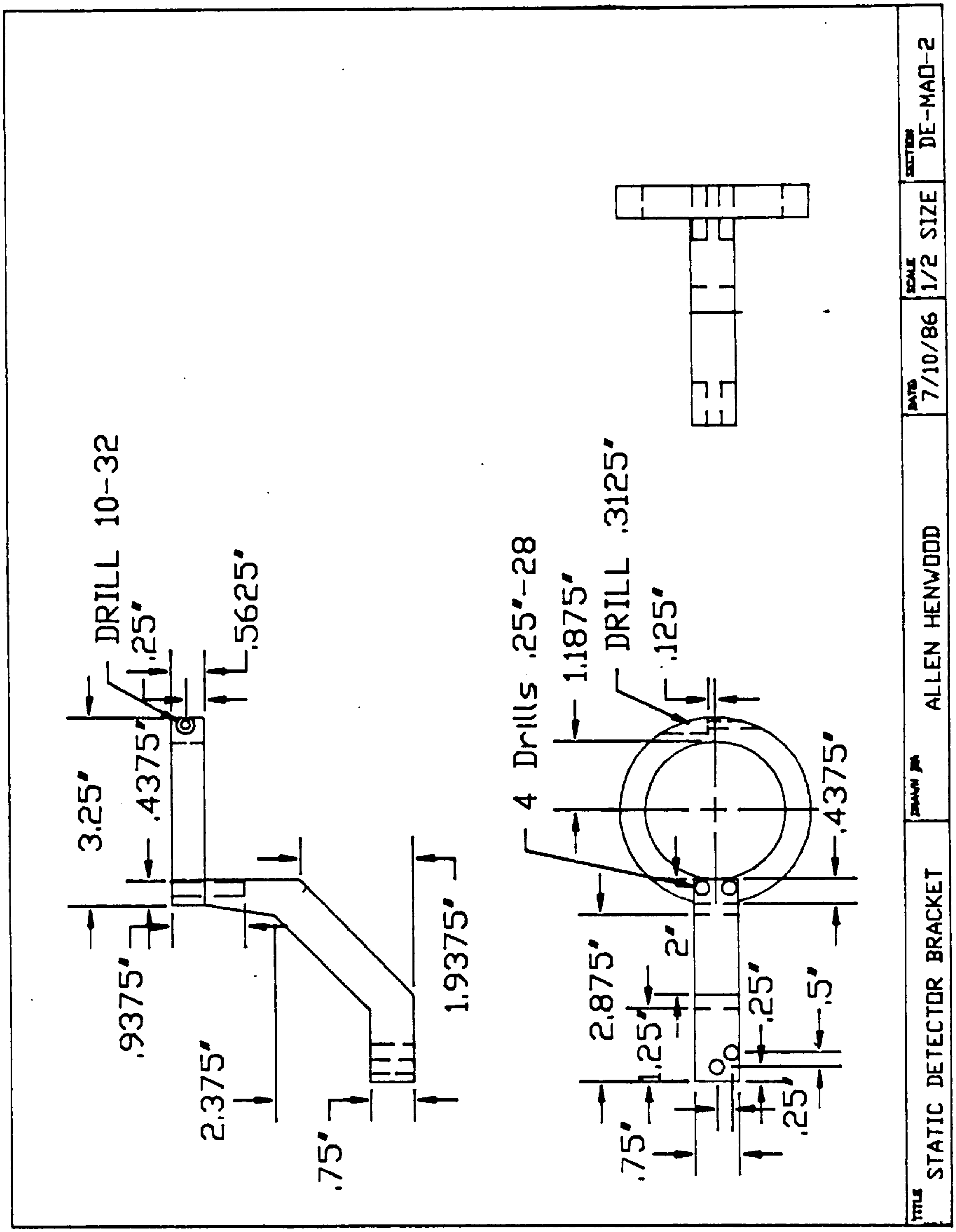

DRILL 10-32
.25"
.5625"
3.25"
.4375"
.9375"
2.375"
.75"
1.9375"
4 Drills .25"-28
1.1875"
DRILL .3125"
.125"
.4375"
2.875"
2"
1.25"
.25"
.5"
.75"
.25"
STATIC DETECTOR BRACKET
ALLEN HENWOOD
7/10/86
1/2 SIZE
DE-MAD-2

FIGURE 10

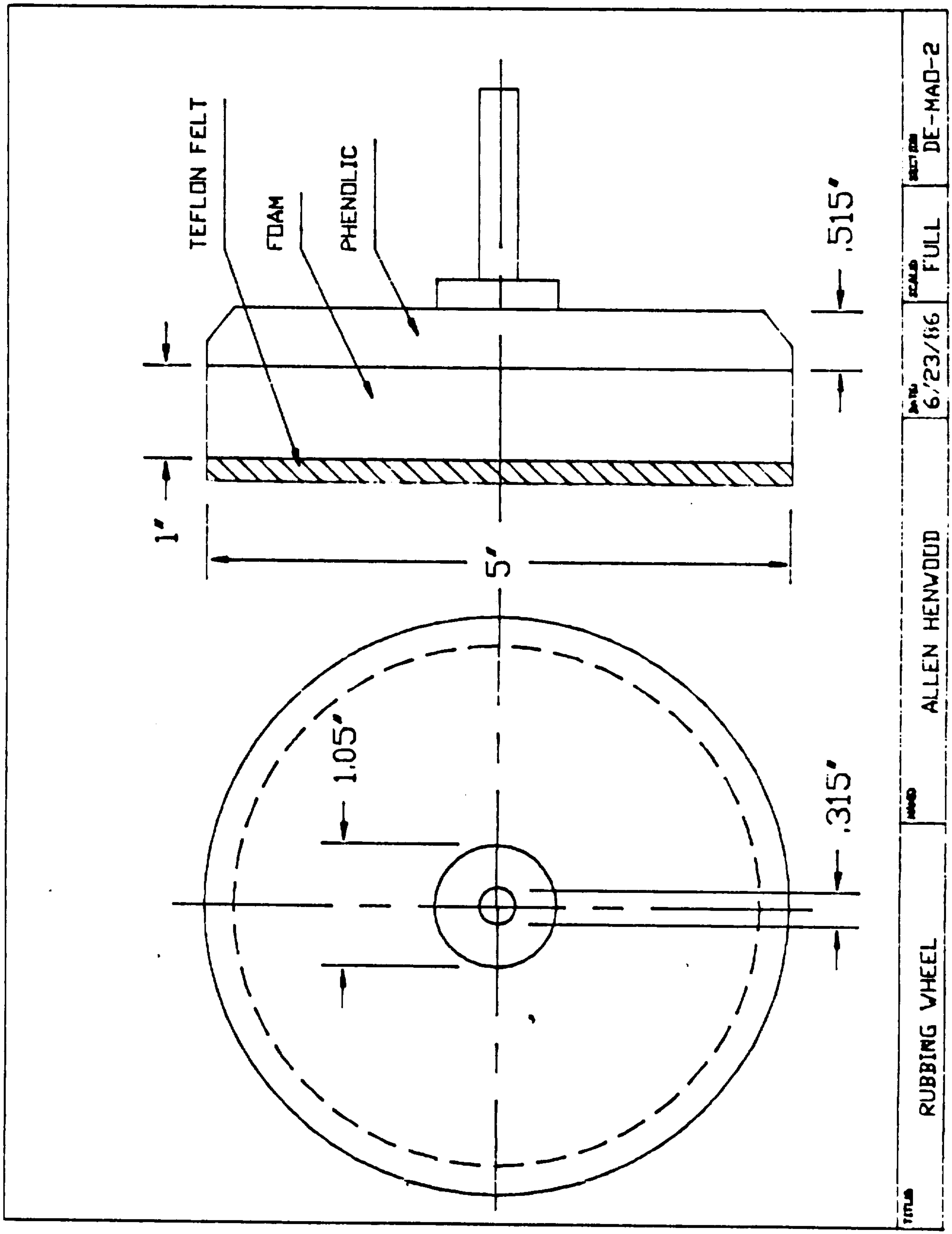

TEFLON FELT
FOAM
PHENOLIC
.515"
1"
5"
1.05"
.315"
RUBBING WHEEL
ALLEN HENWOOD
6/23/86
FULL
DE-MAD-2

FIGURE 11

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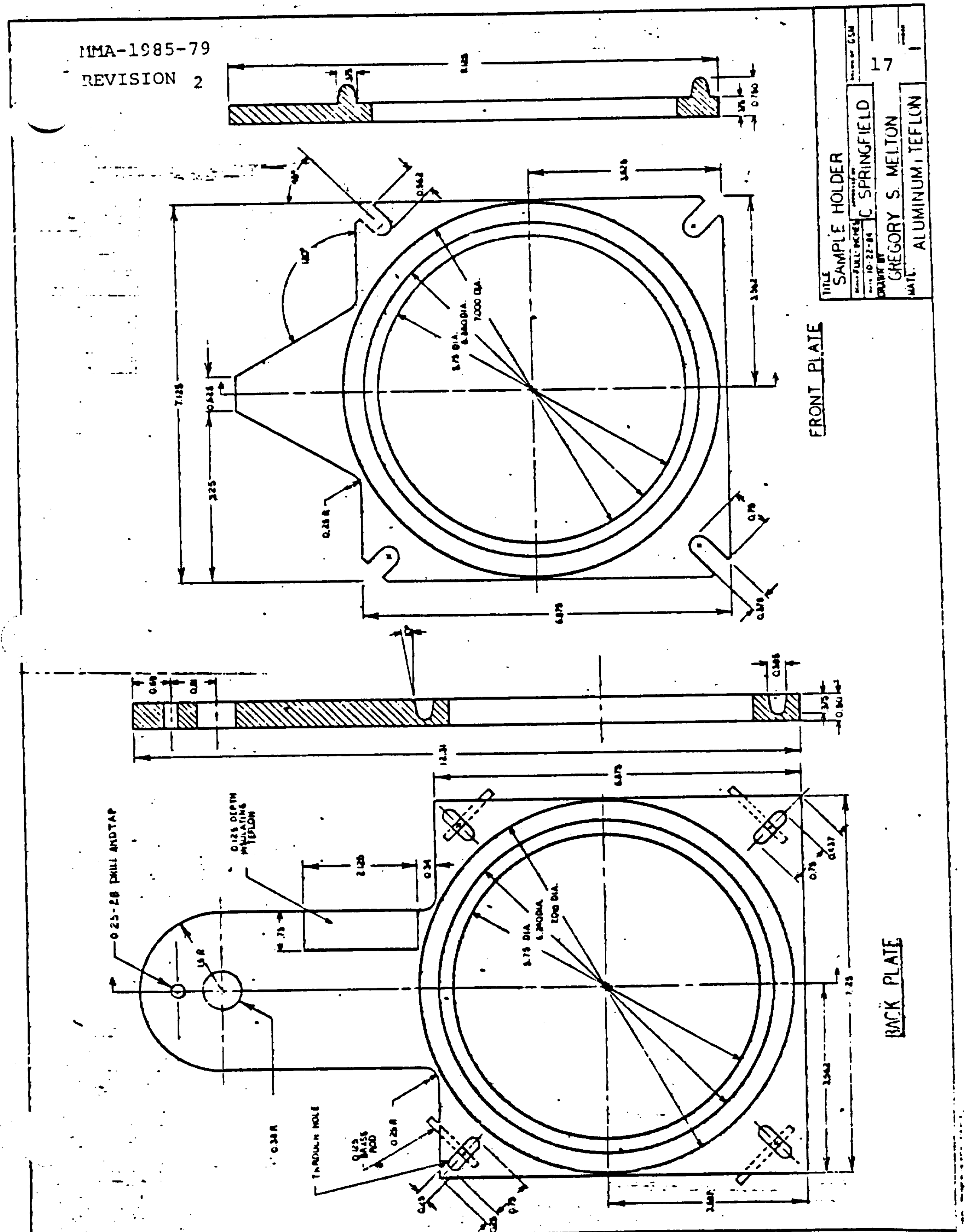

FIGURE 12

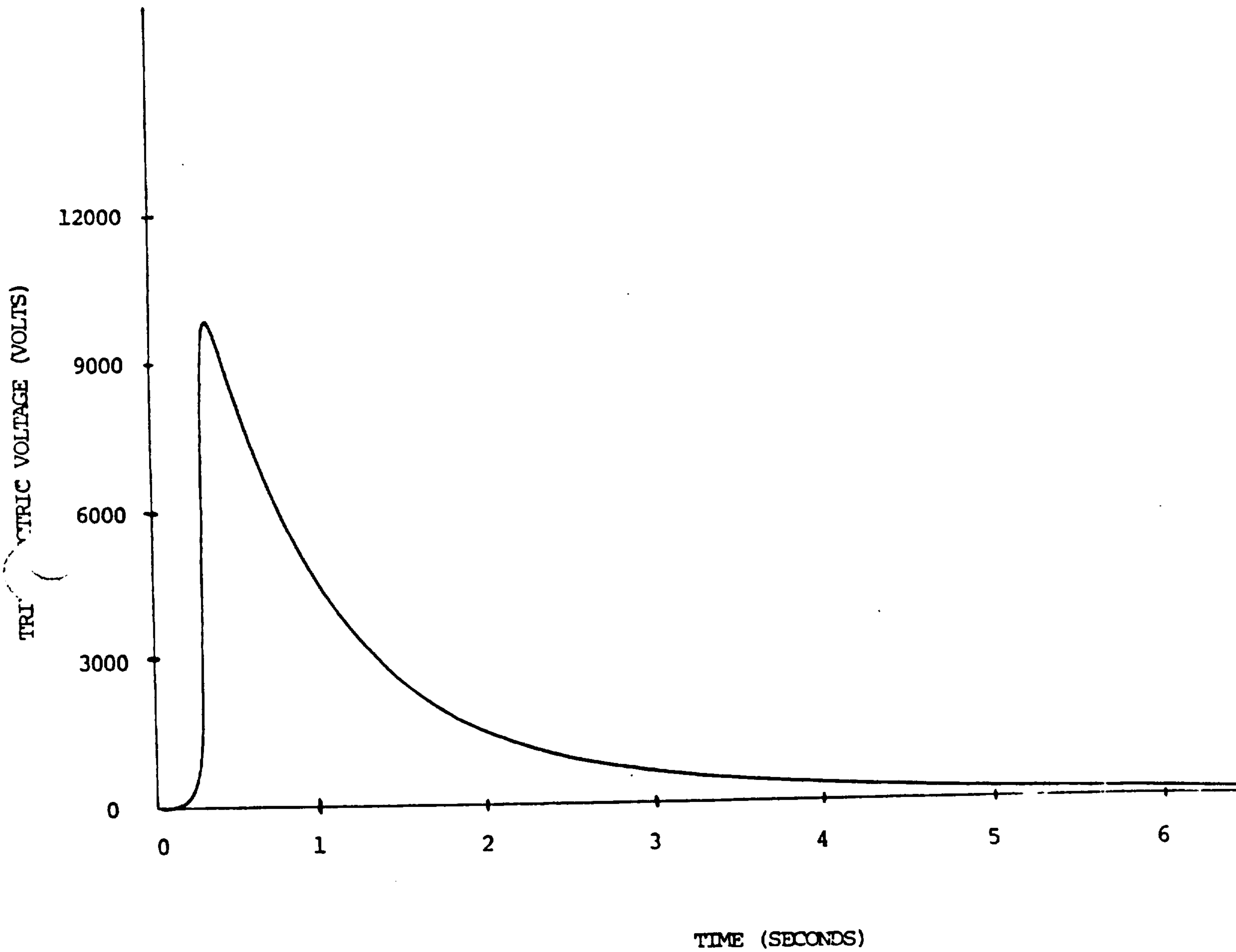

FIGURE 13
TRIBOELECTRIC PLOT X VS Y